भारतीय मानक
Indian Standard

IS 3025 (Part 4) : 2021

जल एवं अपशिष्ट जल के नमूने लेने तथा परीक्षण (भौतिक एवं रसायन) की पद्धतियां

भाग 4 रंग

(दूसरा पुनरीक्षण)

Methods of Sampling and Test (Physical and Chemical) for Water and Waste Water

Part 4 Colour

(Second Revision)

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Water Quality Sectional Committee, CHD 36

FOREWORD

This Indian Standard (Part 4) (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Water Quality Sectional Committee had been approved by the Chemical Division Council.

Colour in surface and ground waters results from natural organic matter, such as humus, peat materials, plankton and weeds, as well as inorganic ions, such as iron and manganese. Industrial waters may contain lignins, tannins, dyes and other organic and inorganic chemicals that impart colour to water. Suspended particles, such as clay, algae, and oxides of iron and manganese give an appearance of colour and they shall be removed before measurement.

Colour is removed from potable water supplies due to health concerns and aesthetic reasons. Colour is also removed from water used for industrial application. In schedule VI of the *Environmental (Protection) Rules*, 1986, with respect to discharge of environmental pollutants through effluents, it is mentioned that “all efforts should be made to remove colour and unpleasant odour as far as practicable”. Hence, standardized test methods to measure colour of water is important.

The term ‘colour’ in this standard refers to ‘true colour’, that is, the colour which is measured after removing the turbidity caused by suspended particles. The term ‘apparent colour’ includes not only the colour due to substances in solution, but also that due to the suspended particles. Hence, the measurement done using the original sample, without removing the suspended particles, is the measurement of ‘apparent colour’.

This standard was published in 1983 to supersede **5** of IS 2488 (Part 1) : 1966 ‘Methods of sampling and test for industrial effluents’ Part 1 and **5** of IS 3025 : 1964 ‘Methods of sampling and test (physical and chemical) for water used in industry’. The second revision of the standard has been undertaken to include the following changes:

a) Spectrophotometric single wavelength method added;
b) Requirement of *p*H monitoring added;
c) Details of apparatus and reagents updated; and
d) Sample handling and preparation added.

In the preparation of this standard, considerable assistance has been derived from the following publication:

Standard Methods for the Examination of Water and Wastewater, American Public Health Association, 22nd Edition, 2012.

There is an existing ISO standard, ISO 7887 : 2011 for the determination of colour, which prescribes 4 methods for measurement of colour. However, two of the four methods (A and D) are visual comparison methods that are qualitative in nature. The other two methods (B and C) are spectrophotometric methods that are similar in principle with the spectrophotometric single wavelength method as prescribed in this standard. ISO 7887 does not contain the multi wavelength method for determination of hues, luminance and purity of colour, which is included in this standard. Hence, the Committee responsible for developing this standard decided not to adopt ISO 7887.

The composition of the committee responsible for the formulation of this standard is given at Annex A

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’.

Indian Standard

METHODS OF SAMPLING AND TEST (PHYSICAL AND CHEMICAL) FOR WATER AND WASTE WATER

PART 4 COLOUR

(Second Revision)

1 SCOPE

This standard (Part 4) prescribes the following methods of test for the determination of colour:

a) Platinum cobalt (visual comparison method),
b) Spectrophotometric — Single wavelength method, and
c) Spectrophotometric — Multi wavelength method.

2 REFERENCES

The following Indian Standards contains provisions which through reference in this text, constitutes provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standard indicated below:

IS No.	*Title*
265 : 1993	Hydrochloric acid
266 : 1993	Sulphuric acid
376 : 1986	Sodium hydroxide, analytical reagent
1070 : 1992	Reagent grade water

3 SAMPLE HANDLING AND PRESERVATION

3.1 Sample Collection

Collect samples in pre-cleaned amber glass bottles or plastic bottles, covered to keep out light. Rinse bottles with sample once before filling the sample. Preferably take a sample of at least 100 ml. Analyze sample within 24 h of collection to prevent any interference due to possible biological activity or physical changes. Refrigerate the samples at 4 °C until analysis and bring the temperature to room temperature before measurement.

3.2 Sample Preparation

Check the *p*H of the sample. If the *p*H is outside the range of 4 to 10, adjust the *p*H to 7 and note the adjustment.

If true colour is to be measured, wash membrane filter and filter assembly by passing at least 50 ml distilled water through filter. Filter about 25 ml sample through the filter assembly and discard filtrate. Then, filter a further portion of about 50 ml through the same assembly and retain the filtrate for analysis.

4 PLATINUM COBALT (VISUAL COMPARISON) METHOD

4.1 Principle

Colour is measured by visual comparison of the sample with platinum – cobalt standards. One unit of colour is that which is produced by the solution containing 1 mg of platinum per litre in the form of chloroplatinate ion.

4.2 Application

The platinum cobalt method is applicable to natural waters, potable waters, and to domestic wastewater. It is not applicable to highly coloured industrial wastewaters.

4.3 Interferences

4.3.1 Very slight amounts of turbidity interfere with the determination. Therefore samples showing visible turbidity shall be pretreated by centrifugation or filtration. A 0.45 µm pore size cellulose membrane filter of 22 mm or 47 mm diameter or glass fiber filters may be used for filtration. For colloidal particulate matter containing Mn or Fe oxides, smaller pore sizes of 0.2 or 0.22 µm or even ultra-filtration may be required. Glass, TFE or stainless steel assembly is used to hold the filters.

4.3.2 The method is *p*H dependent. Colour of water normally increases with increase in *p*H value unless the coloured ion precipitates. Hence, it is a good practice to report the *p*H at which colour is determined.

4.3.3 Use of filter paper may result in removal of some of the colour, leading to erroneous results. Therefore, filter paper should not be used for determination of true colour.

4.4 Apparatus

4.4.1 *Nessler Tubes* — Matched, 50 ml capacity, tall form.

4.4.2 *pH Meter* — For sample *p*H measurement.

4.4.3 *Filter and Filter Assembly* — Use a 0.45 µm pore diameter cellulose membrane filter of 22 or 47 mm diameter. Glass fiber filters can also be used. Rinse filters before use and monitor filter blanks. Smaller pore size filters of 0.2 or 0.22 µm or even ultrafiltration may be used to remove colloidal particles such as Fe and Mn oxides. Use a glass, TFE or stainless steel assembly to house the selected filter discs.

4.5 Reagent

4.5.1 *Reagent Grade Water*, conforming to IS 1070.

4.5.2 *Pottasium Chloroplatinate,* K_2PtCl_6, analytical grade.

4.5.3 *Cobaltous chloride*, $CoCl_2.6H_2O$, analytical grade.

4.5.4 *Hydrochloric Acid*, HCl, conforming to analytical reagent grade of IS 265.

4.5.5 *Sodium Hydroxide*, NaOH, conforming to IS 376.

4.6 Preparation of Standards

4.6.1 *Standard chloroplatinate Stock Solution*

Dissolve 1.246 g of potassium chloroplatinate and 1.00 g crystalized cobaltous chloride in water containing 100 ml concentrated HCl and dilute to 1 000 ml with distilled water. This stock solution is equivalent to 500 colour units (500 CU).

4.6.2 Prepare standards having CU of 1, 2, 5, 10, 15, 20, 25, 30, 40, 50, 60 and 100 by diluting 0.2, 0.4, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 8.0, 10.0, 12.0 and 20.0 ml stock standard chloroplatinate solution with water to a volume of 100 ml. Transfer to nessler tubes for use as standards.

4.6.3 Protect these standards against evaporation and contamination by use of clean inert stoppers. Keep them in the dark when not in use and do not keep for more than 1 month. The standards should also be protected against absorption of ammonia, which causes increase in colour.

4.7 Procedure

4.7.1 *Apparent Colour*

Observe the colour of the sample by filling a matched Nessler tube to the 50 ml mark with sample and compare with standards. Compare by looking vertically downward through the tubes towards a white surface placed at such an angle that light is reflected upwards through the column of liquid. If the colour exceeds 100 units, dilute the sample with distilled water until the colour is in the range of the standards.

4.7.2 *True Colour*

To measure true colour, first filter the sample, as given in **3.7.2**. Compare the filtered sample with distilled water to ensure that turbidity has been removed. If the sample is clear, then compare with the standards as given in **3.8.1**.

4.8 Calculation

Calculate the colour units as follows:

$$\text{Color units} = \frac{50 \times A}{B}$$

where

A = estimated colour of diluted sample, and

B = volume, in ml, of sample taken for dilution.

4.9 Report

The unit for true colour is CU. If samples are not filtered, report data as apparent CU. Report the results in whole numbers as follows:

Colour Units	*Record to Nearest*
1 to 50	1
51 to 100	5
101 to 250	10
251 to 500	20

Also, report the sample *p*H at which colour was determined.

5 SPECTROPHOTOMETRIC — SINGLE WAVELENGTH METHOD

5.1 Principle

Colour is determined spectrophotometrically at a wavelength between 450 and 465 nm, with platinum cobalt solutions as standards. True colour of samples and platinum cobalt standards follow Beer’s Law.

5.2 Application

This method is applicable for surface waters, potable waters and both domestic and industrial wastewaters. Only true colour is measured using this method.

5.3 Interference

5.3.1 The primary interference is from colloidal suspended particles that scatter light at the wavelength of the spectrophotometric method. Hence, it is mandatory to remove suspended particles for this method.

5.3.2 *p*H affects the light absorbance of organic matter in solution and also affects the solubility of substances.

Preferably, do not adjust sample *p*H as long as it is between 4 and 10. If *p*H is adjusted, bring it to 7.0 and note the adjustment.

5.4 Method Detection Level

The minimum detectable colour depends on the cell path length. If a 50 mm cell is used in the wavelength range of 450 to 465 nm, then an absorbance of 0.005 yields a minimum detectable colour of 1 CU. Samples with high colour should be diluted suitably such that its absorbance falls within the standard curve. Absorbance readings should fall within the range of 0.005 to 0.8.

5.5 Apparatus

5.5.1 *Spectrophotometer* — The spectrophotometer shall be capable of operating between 450 and 465 nm with lowest count for adjustable wavelength of 1 nm. Matched glass cells with path lengths of 25 mm and above shall be used. Beer's law allows flexibility in selecting cell path length.

5.5.2 *pH Meter* — For sample *p*H measurement.

5.5.3 *Filter and Filter Assembly* — *See* **4.4.3**.

5.6 Reagents

Reagents given in 4.5 to be used.

5.7 Preparation of Standards

Prepare the standards as given in **4.6**.

5.8 Procedure

5.8.1 *Preparation of Standard Curve*

Choose a wavelength between 450 to 465 nm to develop the standard curve as the absorbance of Pt-Co has a broad maximum absorbance within this wavelength range. Fill one cell with distilled water to adjust absorbance to zero in the instrument. Then read absorbance of each colour standard and prepare a standard curve of CU *versus* absorbance.

5.8.2 *Spectrophotometer Measurement*

Use the same wavelength and same length of glass cell used for developing the standard curve. Fill one spectrophotometer cell with distilled water to adjust absorbance to zero in the instrument. Rinse the other cell with sample and then fill up. Place cell in spectrophotometer and read absorbance. Determine sample colour using absorbance readings and standard curve.

6 SPECTROPHOTOMETRIC — MULTI WAVELENGTH METHOD

6.1 Principle

The colour of a filtered sample is expressed by three parameters which are perceived by eyes. The hue (red, green, yellow etc.) is designated by the term 'dominant wavelength', the degree of brightness by 'luminance' and the saturation (pale, pastel etc.) by 'purity'. These parameters are determined from the light transmission characteristics of the filtered sample by means of a spectrophotometer.

6.2 Application

This method is applicable for surface waters, potable waters and both domestic and industrial wastewaters. Only true colour is measured using this method.

6.3 Interference

The primary interference is from colloidal suspended particles that scatter light at the wavelength of the spectrophotometric method. Hence, it is mandatory to remove suspended particles for this method.

6.4 Apparatus

6.4.1 *Spectrophotometer* — Capable of measuring the transmittance/absorbance at a narrow (10 nm or less) spectral band, and an effective operating range from 400 to 700 nm, along with absorption cell of a minimum of 10 mm path length.

6.4.2 *pH Meter* — For sample *p*H measurement.

6.4.3 *Filter and Filter Assembly* — *See* **4.4.3**.

6.5 Reagents

6.5.1 *Reagent Grade Water* — Conforming to IS 1070.

6.5.2 *Sulphuric Acid*, H_2SO_4 — Conforming to analytical reagent grade of IS 266.

6.5.3 *Sodium Hydroxide*, NaOH — Conforming to IS 376.

6.6 Sample Handling and Preservation

Filter the sample as given in **3.2**. Bring two 50 ml samples to room temperature. Use one sample at the original *p*H and adjust *p*H of the other sample to 7.0 by using H_2SO_4 or NaOH in such a way that the change in volume does not exceed 3 percent.

6.7 Procedure

6.7.1 Thoroughly clean 10 mm absorption cells with detergent and then with distilled water. Rinse twice with filtered sample, and then fill cell with the filtered sample.

6.7.2 Determine transmittance values (in percent) at each visible wavelength value given in Table 1, using the 10 ordinates marked with an asterisk for fairly accurate work and all 30 ordinates for increased accuracy. Set instrument to read 100 percent transmittance on the distilled water blank and make all determinations with a narrow spectral band.

Table 1 Selected Ordinates for Spectrophotometric Colour Determinations

(*Clauses* 6.7.2 *and* 6.8.1)

Ordinate No.	*X*	*Y*	*Z*
		Wavelength, *nm*	
1	424.4	465.9	414.1
2*	435.5*	489.5*	422.2*
3	443.9	500.4	426.3
4	452.1	508.7	429.4
5*	461.2*	515.2*	432.0*
6	474.0	520.6	434.3
7	531.2	525.4	436.5
8*	544.3*	529.8*	438.6*
9	552.4	533.9	440.6
10	558.7	537.7	442.5
11*	564.1*	541.4*	444.4*
12	568.9	544.9	446.3
13	573.2	548.4	448.2
14*	577.4*	551.8*	450.1*
15	581.3	555.1	452.1
16	585.0	558.5	454.0
17*	588.7*	561.9*	455.9*
18	592.4	565.3	457.9
19	596.0	568.9	459.9
20*	599.6*	572.5*	462.0*
21	603.3	576.4	464.1
22	607.0	580.4	466.3
23*	610.9*	584.8*	468.7*
24	615.0	589.6	471.4
25	619.4	594.8	474.3
26*	624.2*	600.8	477.7*
27	629.8	607.7	481.8
28	636.6	616.1	487.2
29*	645.9*	627.3*	495.2*
30	663.0	647.4	511.2
		Factors when 30 ordinates used	
	0.032 69	0.033 33	0.039 38
		Factors when 10 ordinates used	
	0.098 06	0.100 00	0.118 14

* Insert in each column the transmittance value in percent corresponding to the given wavelength. Where limited accuracy is sufficient, only the ordinates marked with an asterisk may be used.

6.8 Calculation

6.8.1 Tabulate the transmittance values corresponding to wavelengths shown in col *X, Y* and *Z*, in Table 1. Add each of transmittance columns and multiply the totals by the appropriate factors (for 10 or 30 ordinates) shown at the bottom of the table to obtain tristimulus values *X, Y* and *Z*. The tristimulus value *Y* is the percent luminance.

6.8.2 Calculate the trichromatic coefficients *x* and *y* from tristimulus values *X, Y* and *Z* by the following equations:

$$x = \frac{X}{X+Y+Z}$$

$$y = \frac{Y}{X+Y+Z}$$

Locate the point (x, y) on one of the chromaticity diagrams shown in Fig. 1 and determine the dominant wavelength (in nm) and purity (in percent) from this diagram.

Determine the hue from dominant wavelength value according to the ranges given in Table 2.

Table 2 Colour Hues for Dominant Wavelength Ranges

(*Clause* 6.8.2)

Dominant Wave Length Range, nm	Colour Hue
400 – 465	Violet
465 – 482	Blue
482 – 497	Blue green
497 – 530	Green
530 – 575	Greenish yellow
575 – 580	Yellow
580 – 587	Yellowish orange
587 – 598	Orange
598 – 620	Orange red
620 – 700	Red
400 – 530c*	Blue purple
530c – 700*	Red purple

**See* Fig. 1 for significance of 'c'

6.9 Report

Report the colour characteristics at *p*H 7.0 and at also at original *p*H in terms of dominant wavelength (nm to the nearest unit), hue (for example, blue, blue green, etc), luminance (percent to the nearest unit), and purity (percent, to the nearest unit). Mention the type of instrument, that is, the spectrophotometer, the number of selected ordinates (10 or 30) and the spectral band width (nm) used.

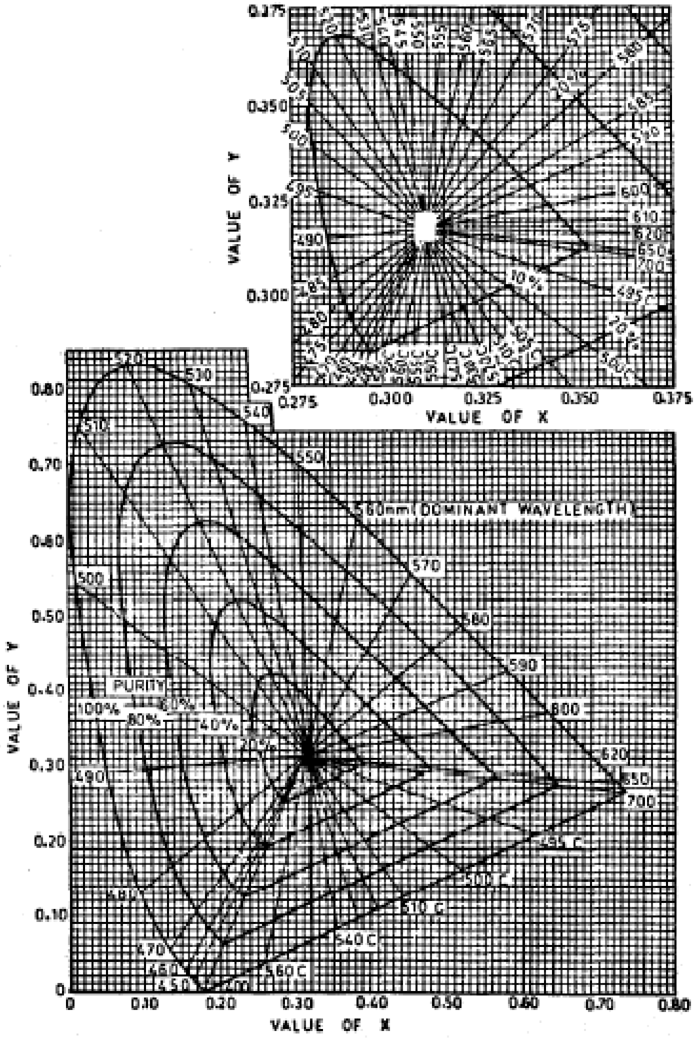

FIG. 1 CHROMATICITY DIAGRAM

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Water Quality Sectional Committee, CHD 36

Organization	*Representative(s)*
Chief Scientist, EPTRI, Hyderabad	Shri N. Raveendhar (***Chairman***)
Avantha Centre for Industrial Research and Development, Yamuna Nagar	Dr Nishi Kant Bhardwaj Dr Sunil Kumar (*Alternate*)
Bhabha Atomic Research Centre, Mumbai	Dr S. K. Sahu Shri I. V. Saradhi (*Alternate*)
Central Ground Water Board, Faridabad	Shri G. C. Pati Shrimati Rumi Mukherjee (*Alternate*)
Central Institute of Mining and Fuel Research, Dhanbad	Dr (Mrs) Bably Prasad Dr Abhay Kumar Singh (*Alternate*)
Central Pollution Control Board, New Delhi	Shri N. C. Durgapal Dr J. C. Babu (*Alternate*)
Confederation of Indian Industry, New Delhi	Shri Shikhar Jain Ms Kamal Sharma (*Alternate*)
Delhi Technological University, New Delhi	Dr (Mrs) Anubha Mandal
Delhi Jal Board	Shri D. R. Arya Shri Sanjeev Kumar (*YP*) (*Alternate*)
Department of Civil Engineering, IIT Madras	Dr Ligy Philip Dr S. Mathava Kumar (*Alternate*)
Envirocare Laboratories Pvt Ltd, Thane	Dr Priti Amritkar Shri Nilesh Amritkar (*Alternate*)
Environment Protection and Training Research Institute, Hyderabad	Dr J. S. Srinivas
FAD 14, Member Secretary	Dr Anil Kapri
Gujarat Pollution Control Board, Gandhinagar	Dr D. N. Vansadia Shri K. B. Vaghela (*Alternate*)
Himachal Pradesh State Pollution Control Board	Dr D. K. Sharma Shri Harish Sharma (*Alternate*)
In personal capacity (*1221, Mahatma Gandhi Road, P. O. - Haridevpur, Kolkata, 70008*2)	Shri Sanjib Kumar Goswami
In personal capacity (*House No. 514, SSST Nagar, Rajpura Road, Patiala 147003*)	Dr H. K. Parwana
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Indian Council for Agricultural Research, New Delhi	Dr M. J. Kaledhonkar R. K. Yadav (*Alternate*)
Indian Institute of Toxicology Research, Lucknow	Dr S. C. Barman Dr Satyakam Patnaik (*Alternate*)

Organization	*Representative(s)*
Indian Oil Corporation Ltd, Faridabad	Dr S. K. Puri
Indian Water Works Association	Shri Vijay Charhate
Karnataka State Pollution Control Board, Bengaluru	Dr B. R. Balagangadharan Dr H. Rupadevi (*Alternate*)
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Member Secretary

Ms Kreeti Das
Scientist 'B' (CHD), BIS

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